

FIG.1

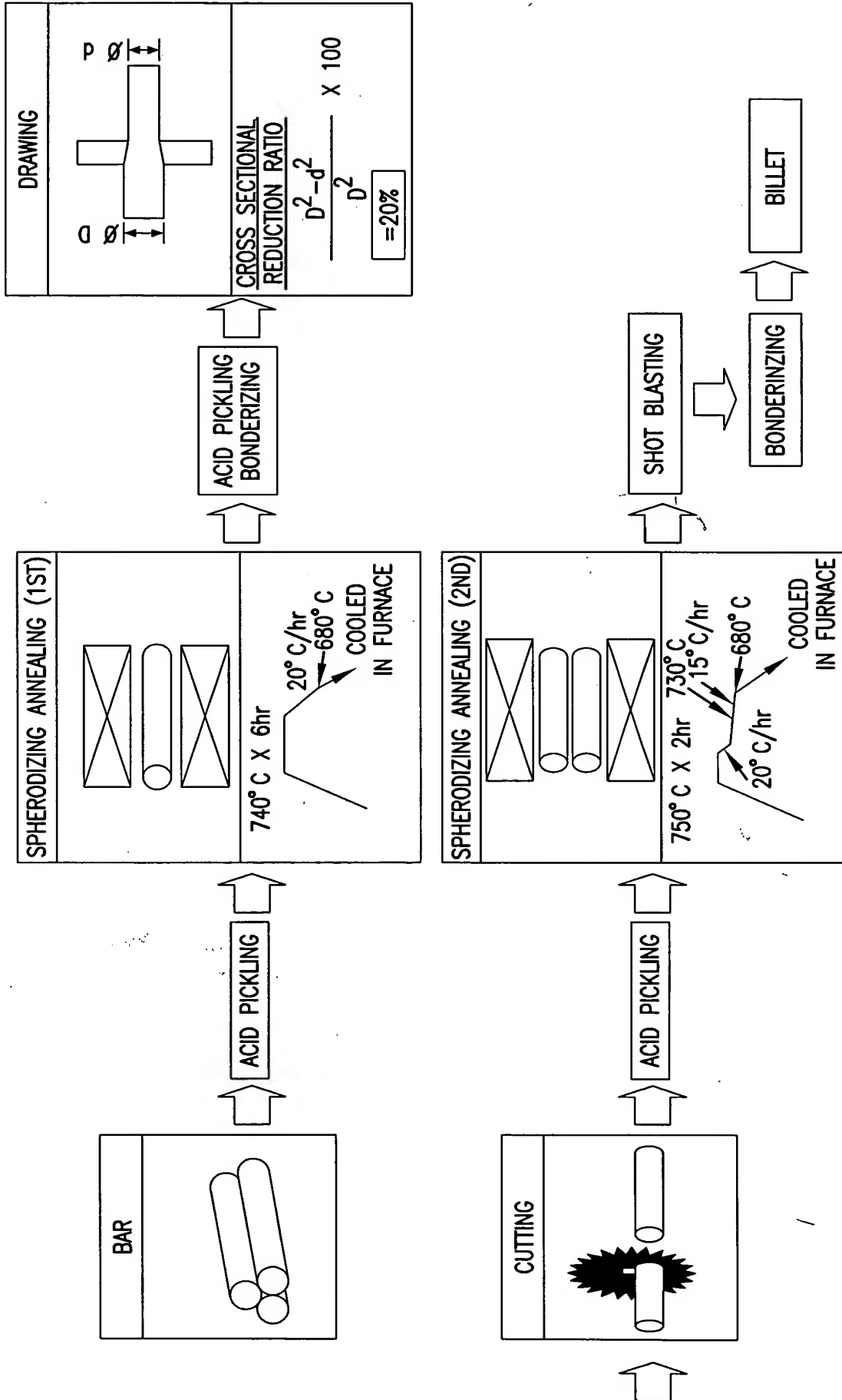


FIG.2

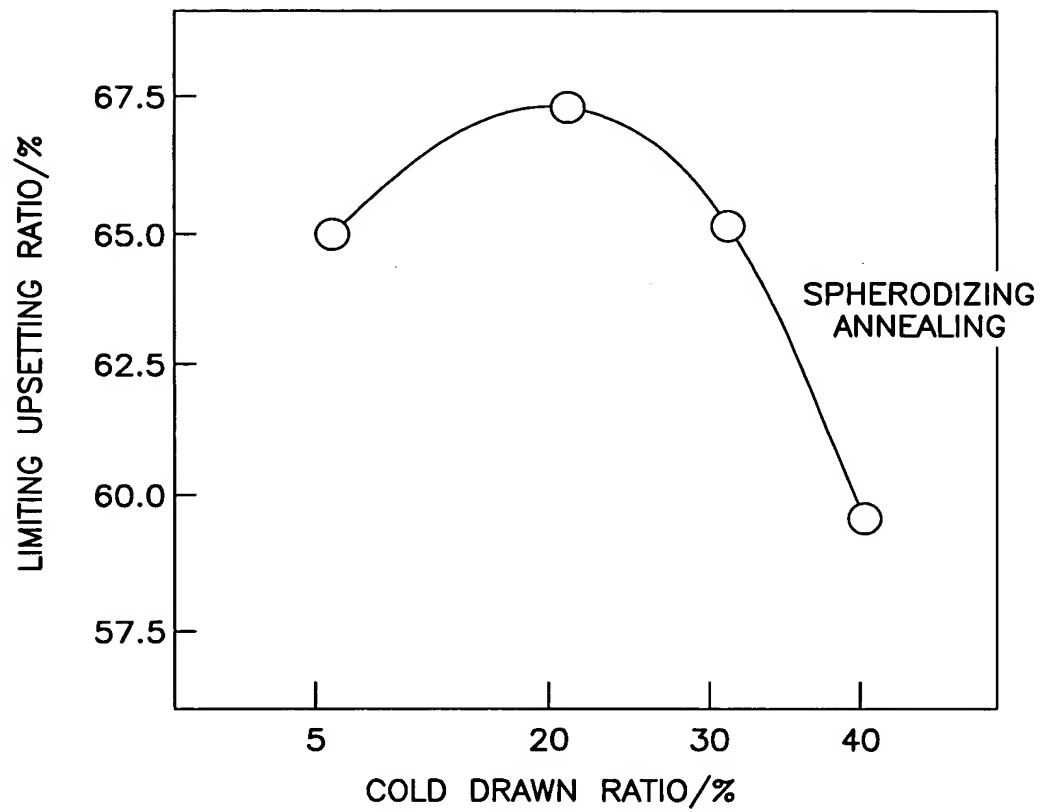


FIG. 3A

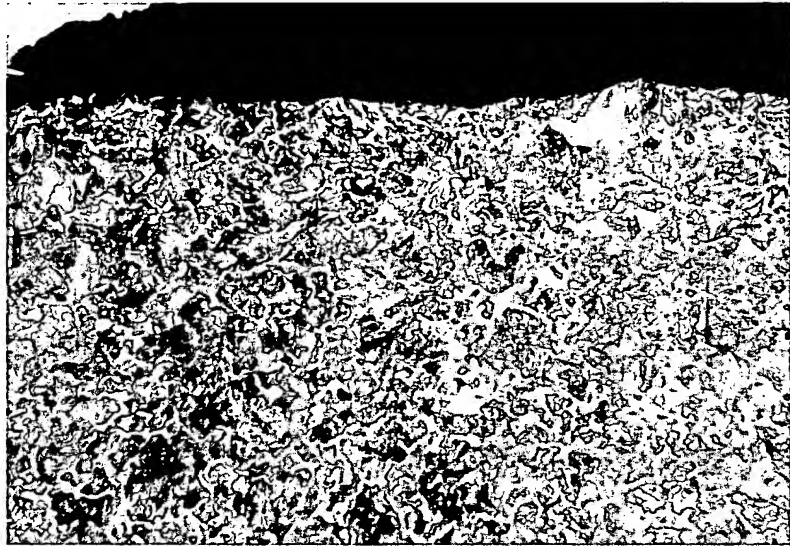


FIG. 3B

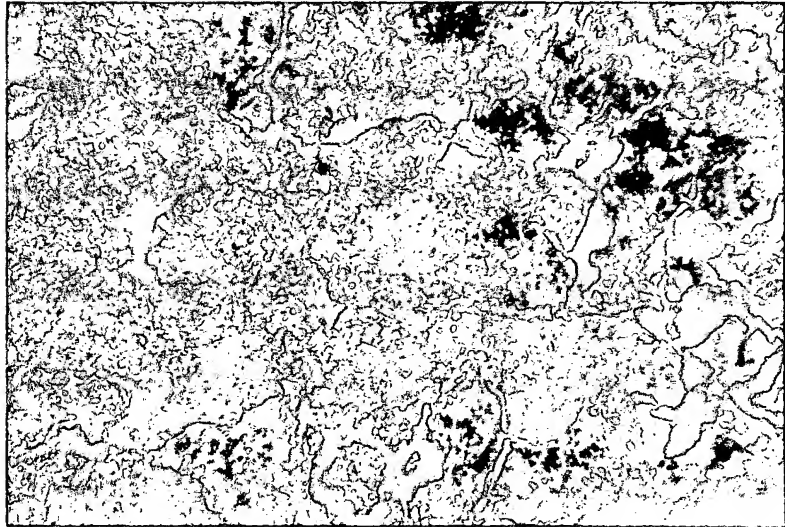


FIG. 4A

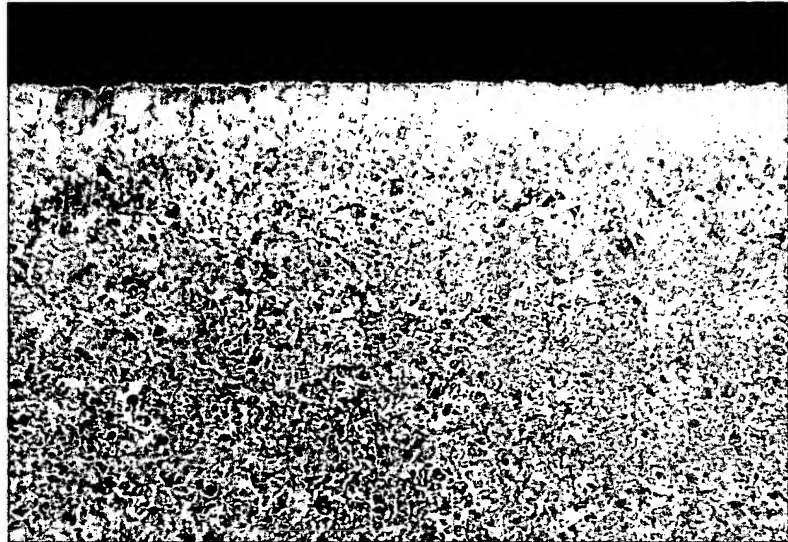


FIG. 4B

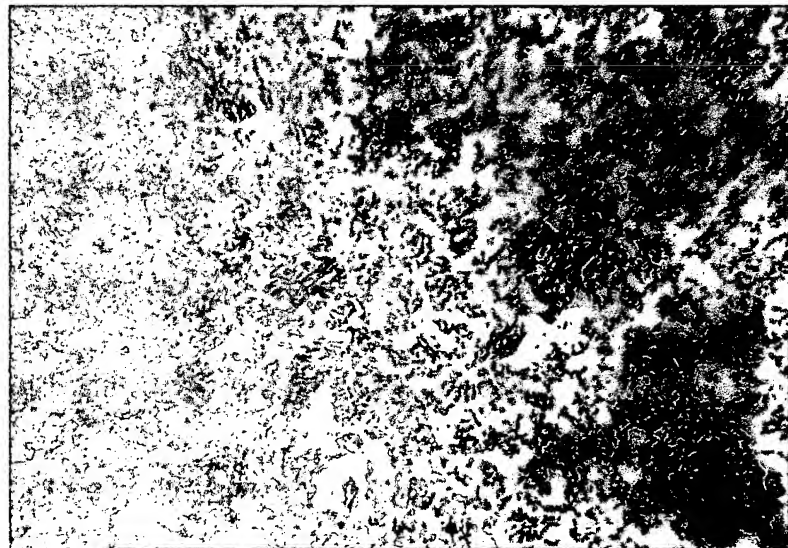


FIG. 5A

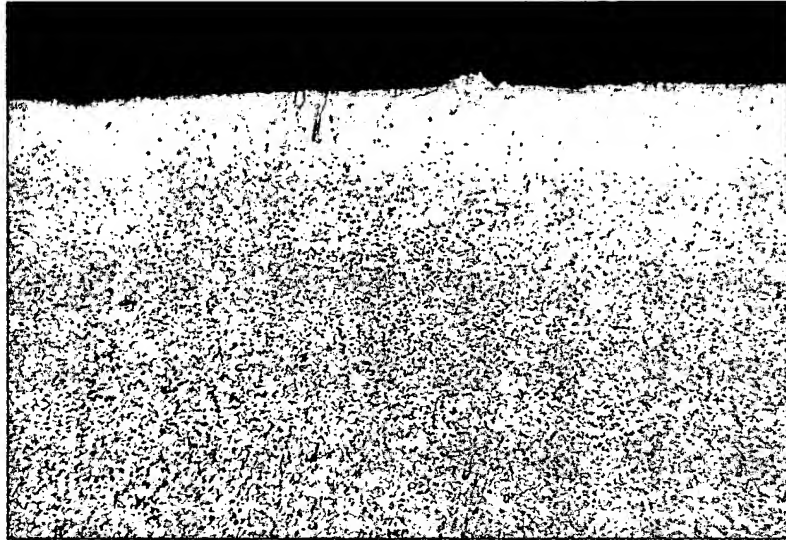


FIG. 5B

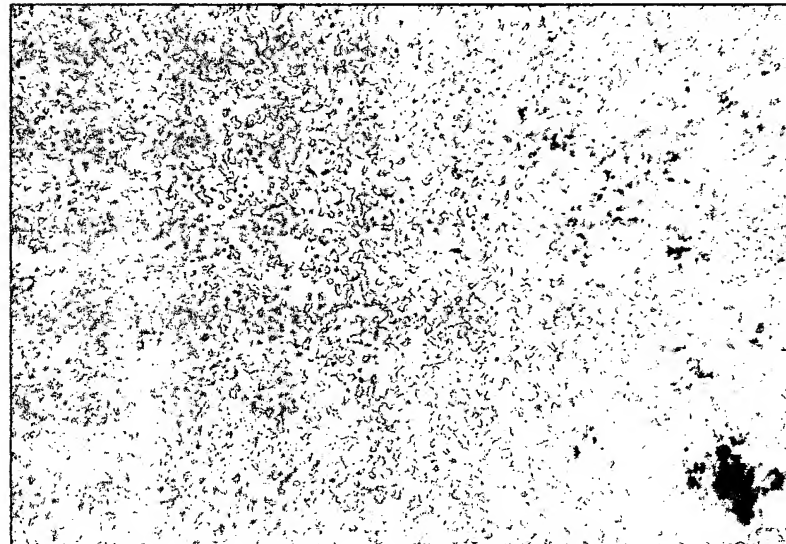


FIG. 6A

MATERIAL 1
ASPECT RATIO = 506%

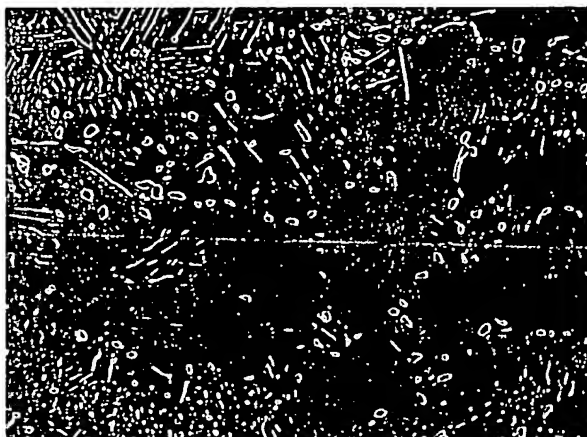


FIG. 6B

MATERIAL 2
ASPECT RATIO = 347%

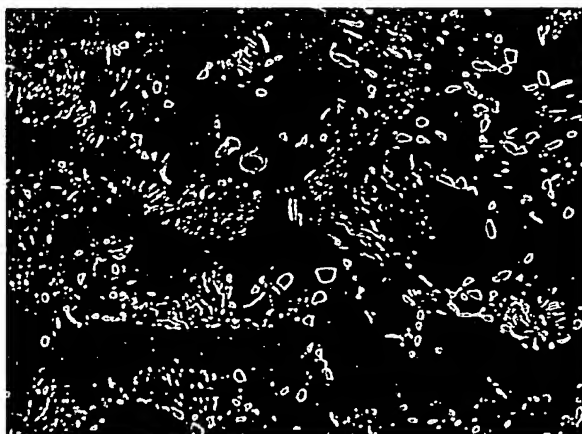


FIG. 6C

MATERIAL 3
ASPECT RATIO = 300%

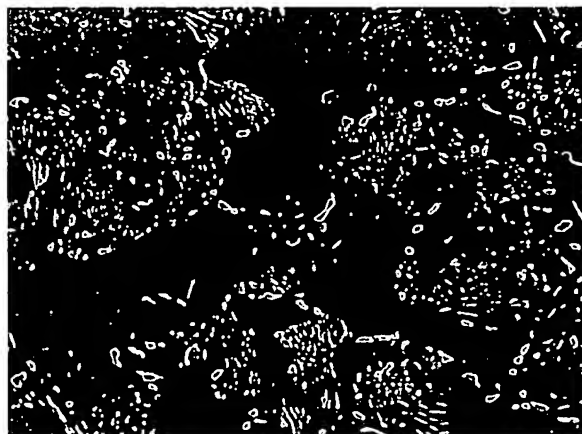


FIG.7

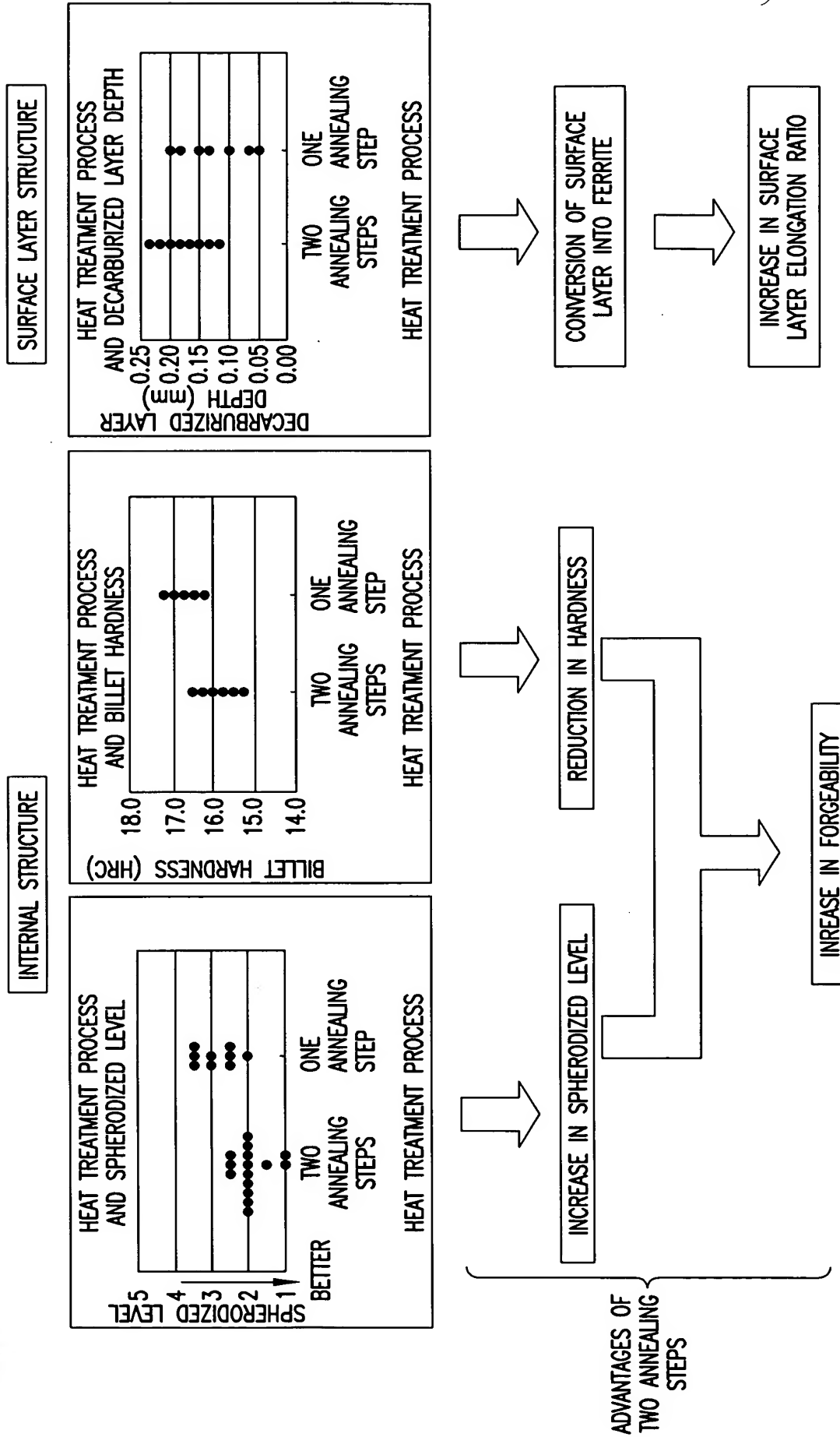


FIG.8

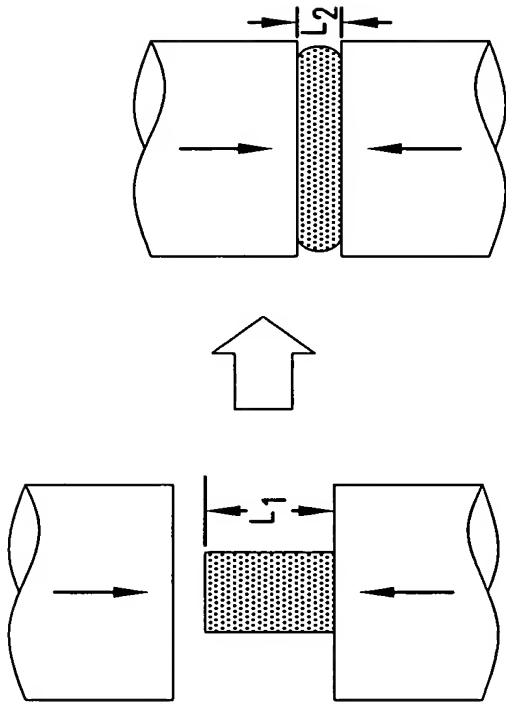


FIG.9

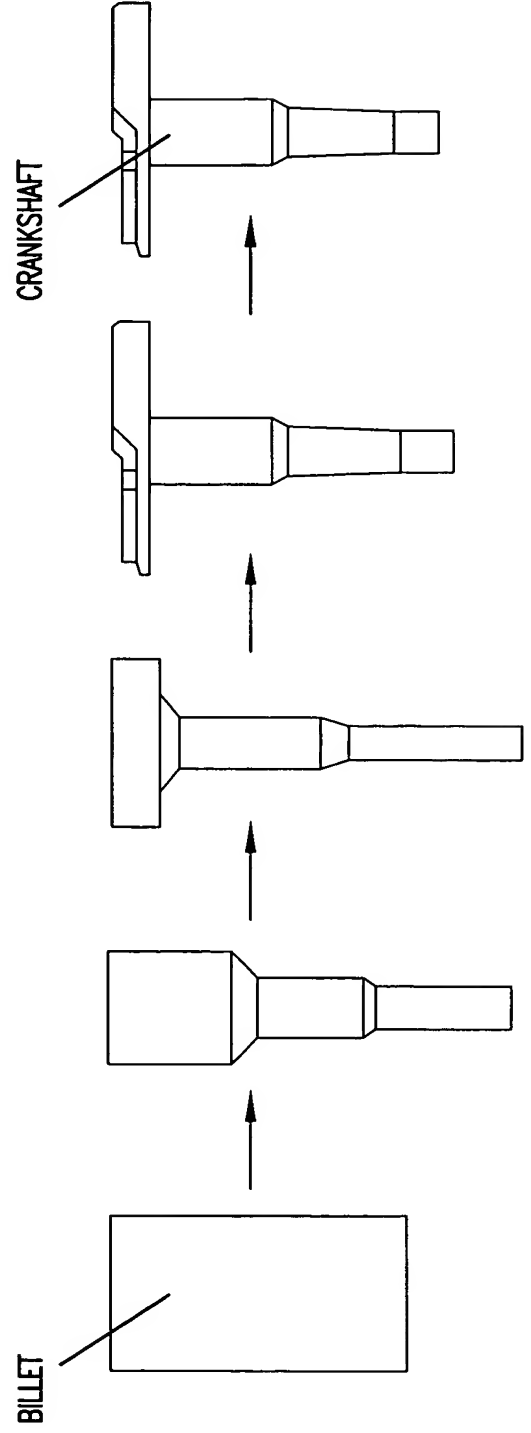


FIG.10

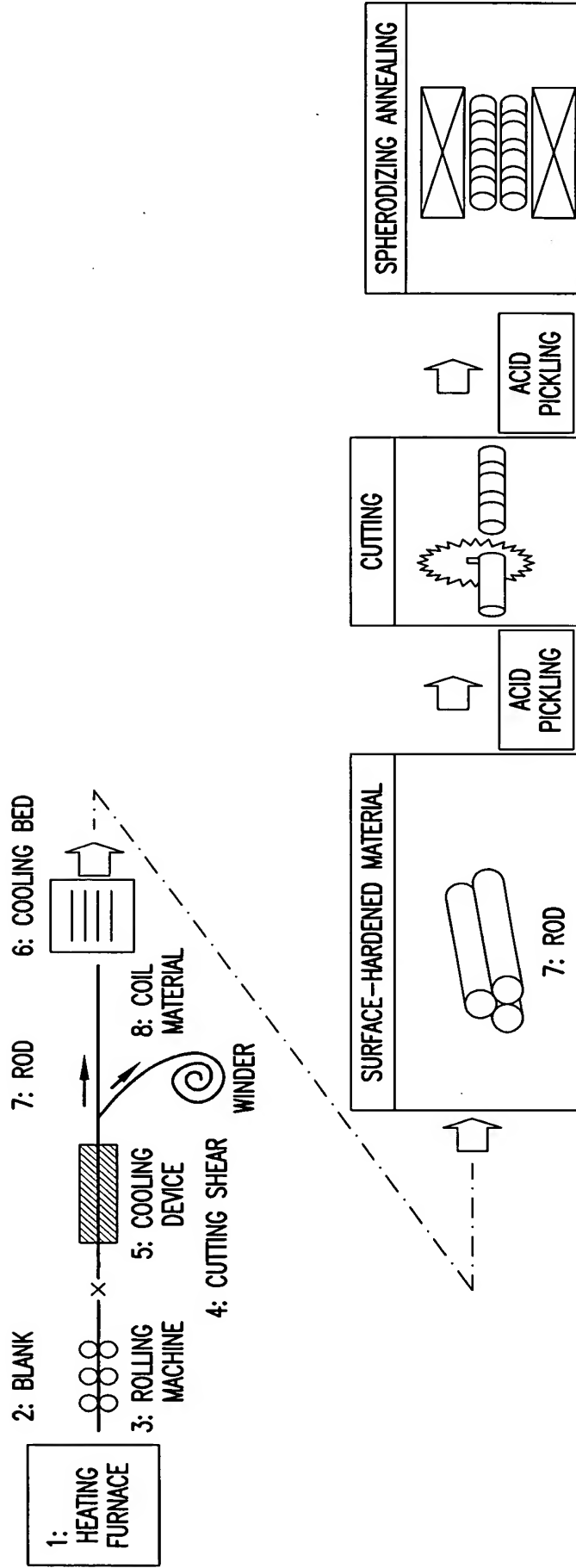


FIG.11A

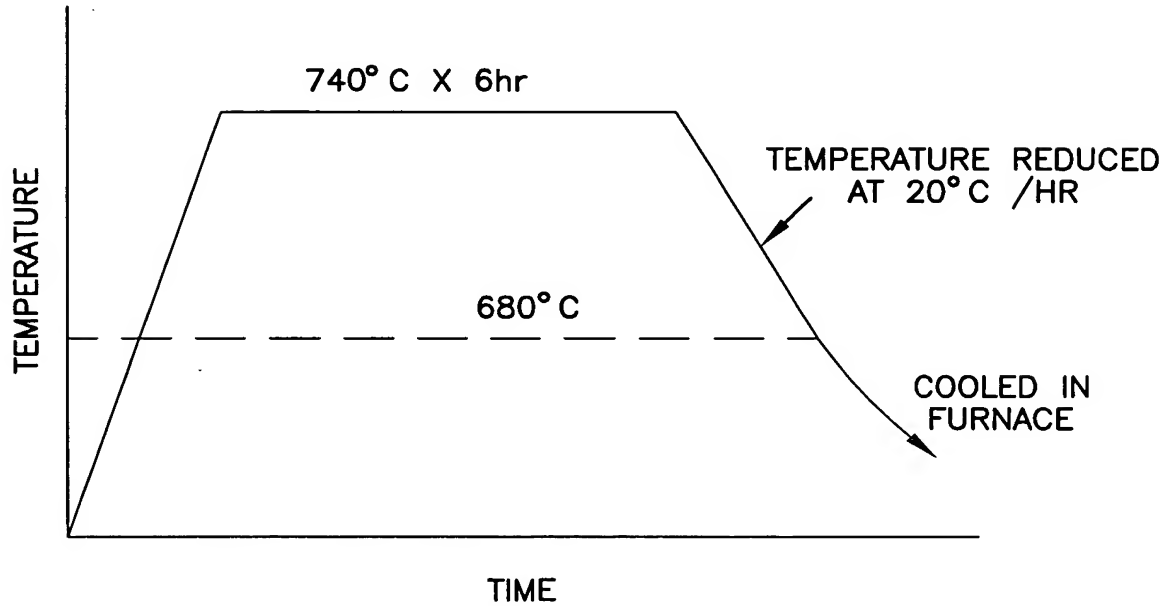


FIG.11B

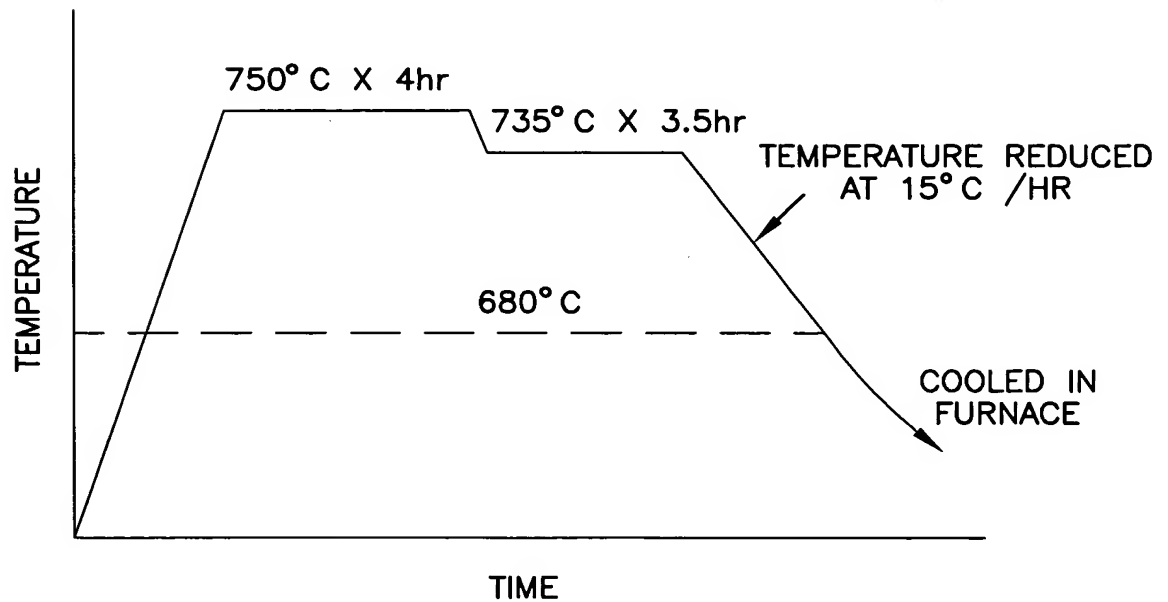


FIG. 12A



MARTENSITIC MATERIAL
PRIOR TO SPHERODIZING ANNEALING
X2. 1

FIG. 12B

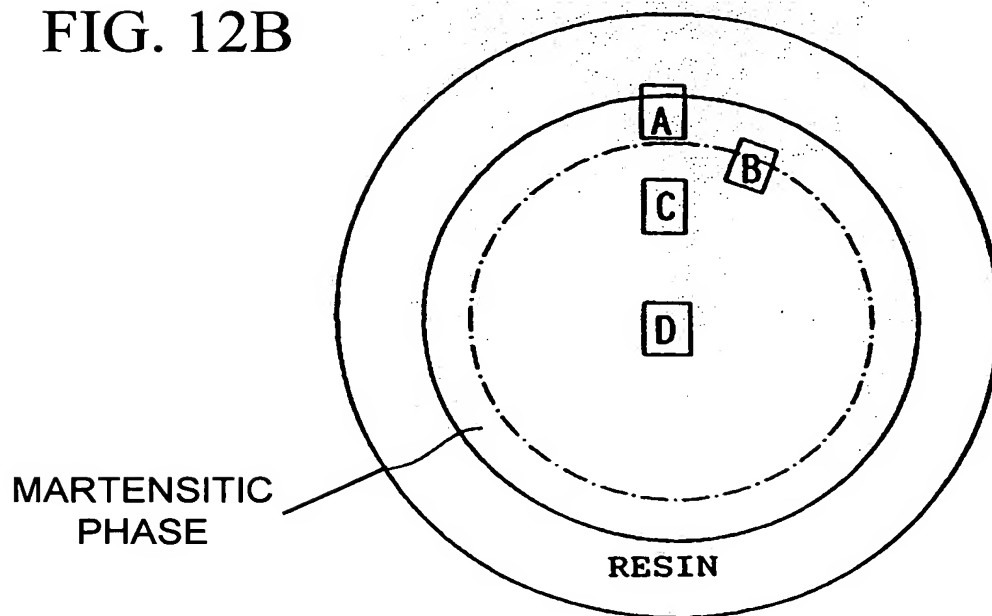
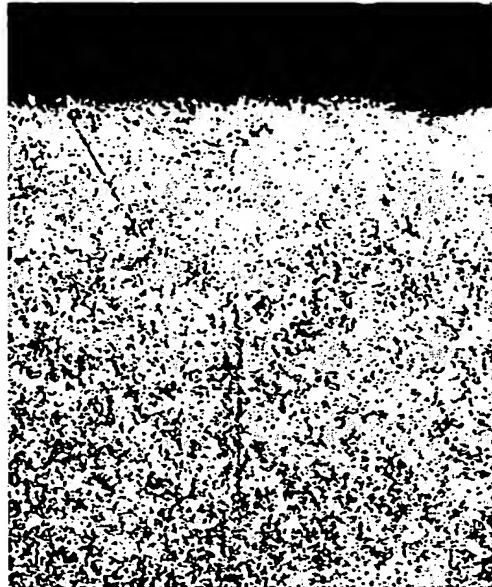
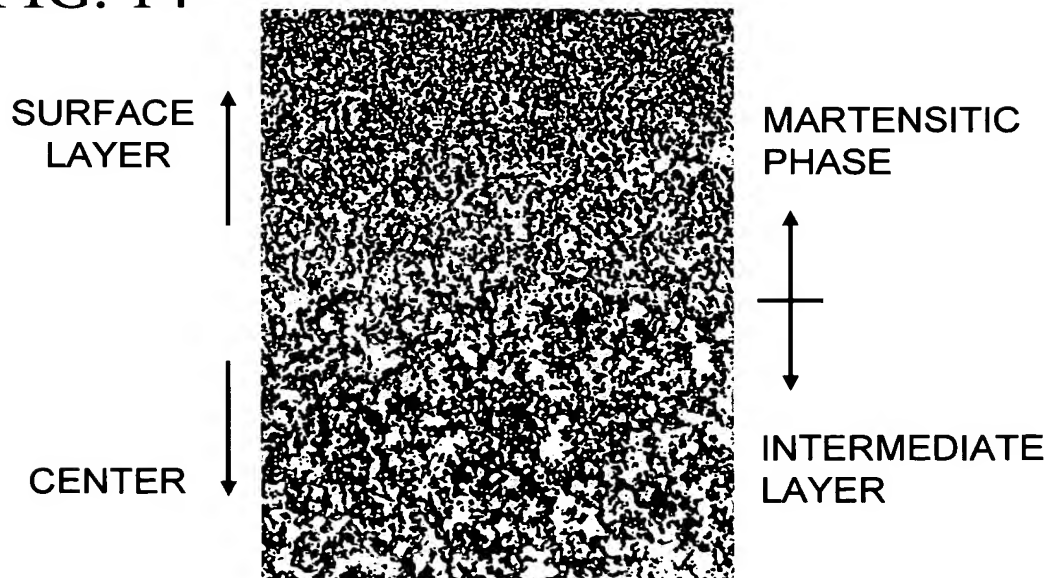


FIG. 13



PRIOR TO SPHERODIZING ANNEALING
SURFACE LAYER X 100

FIG. 14



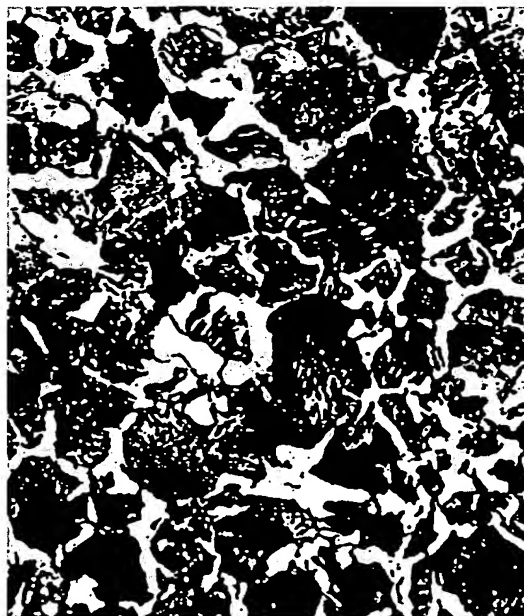
PRIOR TO SPHERODIZING ANNEALING
SURFACE LAYER AND INTERMEDIATE LAYER X 200

FIG. 15



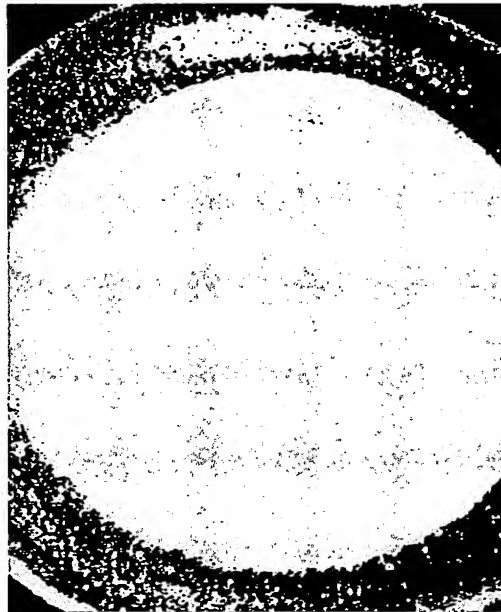
PRIOR TO SPHERODIZING ANNEALING
1/2 R PART X 400

FIG. 16



PRIOR TO SPHERODIZING ANNEALING
CENTRAL PART X 400

FIG. 17A



MARTENSITIC MATERIAL
AFTER SPHERODIZING ANNEALING PATTERN 1
X2. 1

FIG. 17B

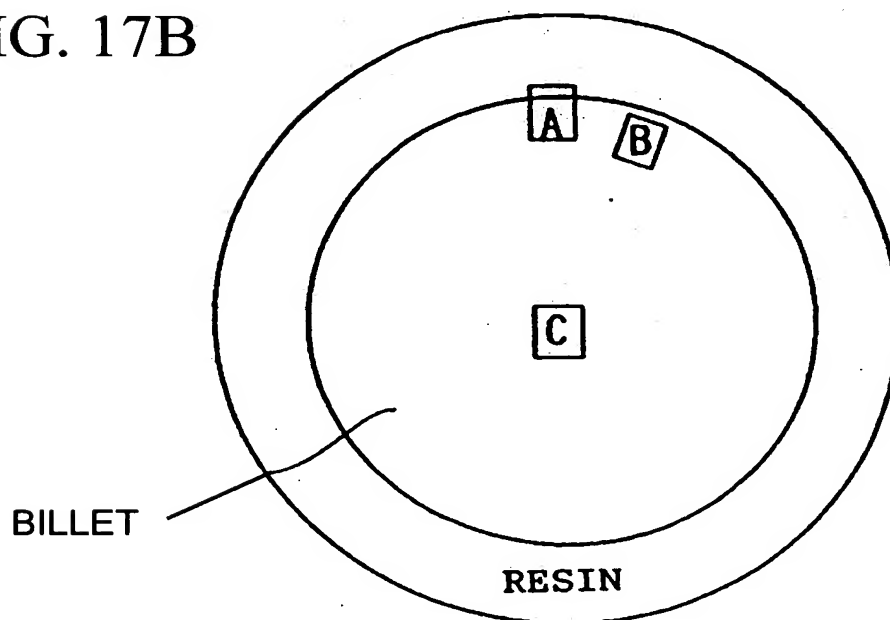
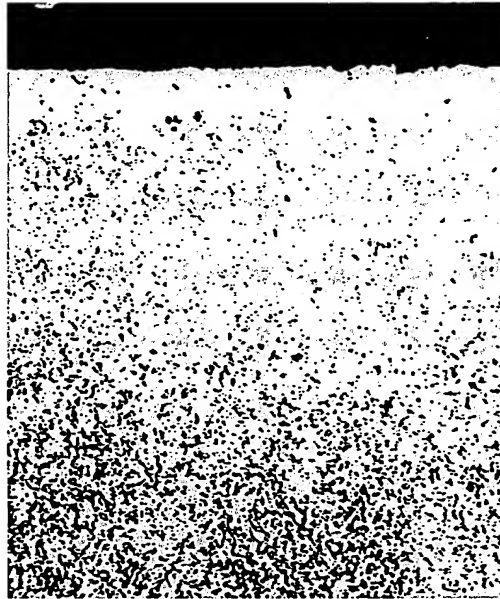
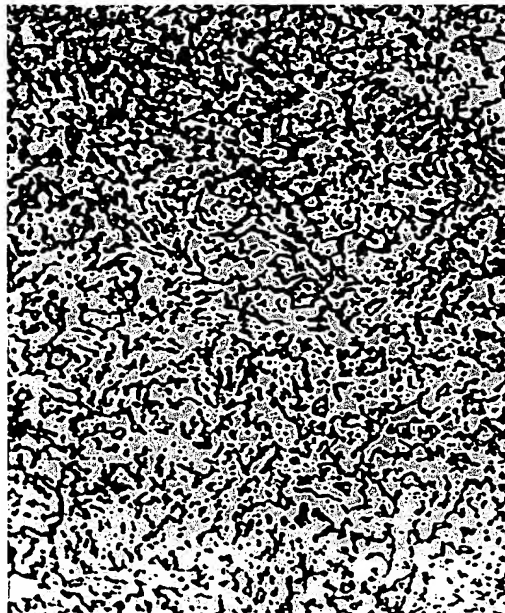


FIG. 18



AFTER SPHERODIZING ANNEALING PATTERN 1
SURFACE LAYER X 100

FIG. 19



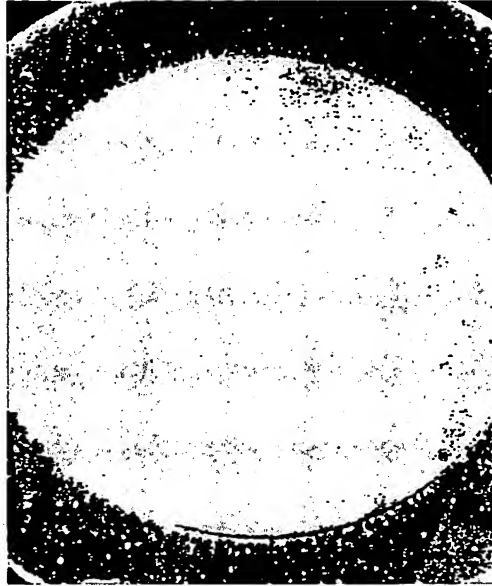
AFTER SPHERODIZING ANNEALING PATTERN 1
SURFACE LAYER X 400

FIG. 20



AFTER SPHERODIZING ANNEALING PATTERN 1
1/2 R PART X 400

FIG. 21A



MARTENSITIC MATERIAL
AFTER SPHERODIZING ANNEALING PATTERN 1
X2. 1

FIG. 21B

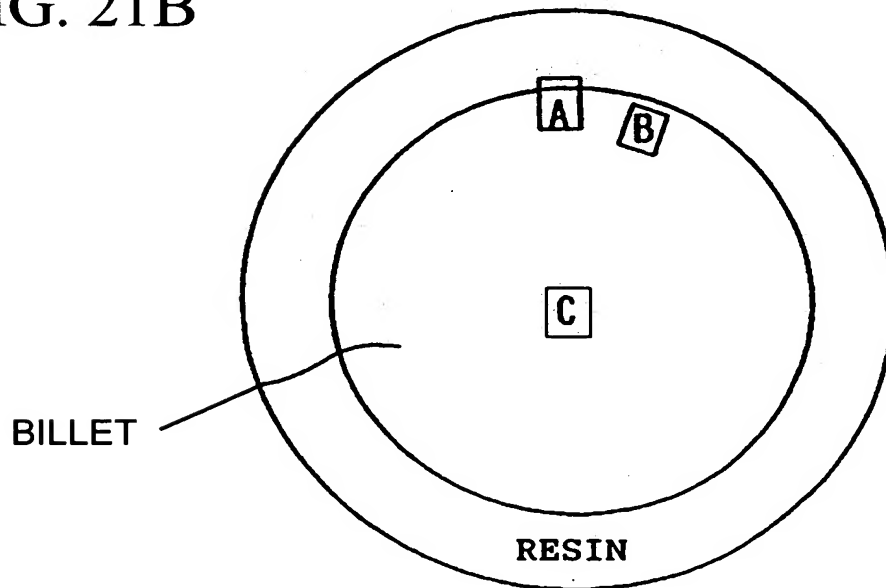


FIG. 24



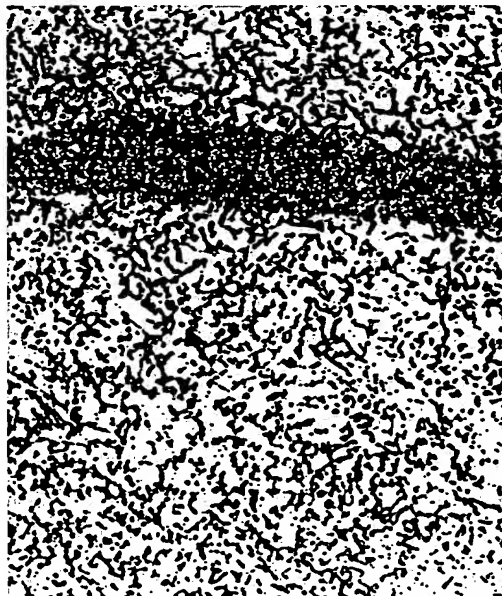
AFTER SPHERODIZING ANNEALING PATTERN 1
1/2 R PART X 400

FIG. 22



AFTER SPHERODIZING ANNEALING PATTERN 2
SURFACE LAYER X 100

FIG. 23



AFTER SPHERODIZING ANNEALING PATTERN 2
SURFACE LAYER X 400

FIG.25

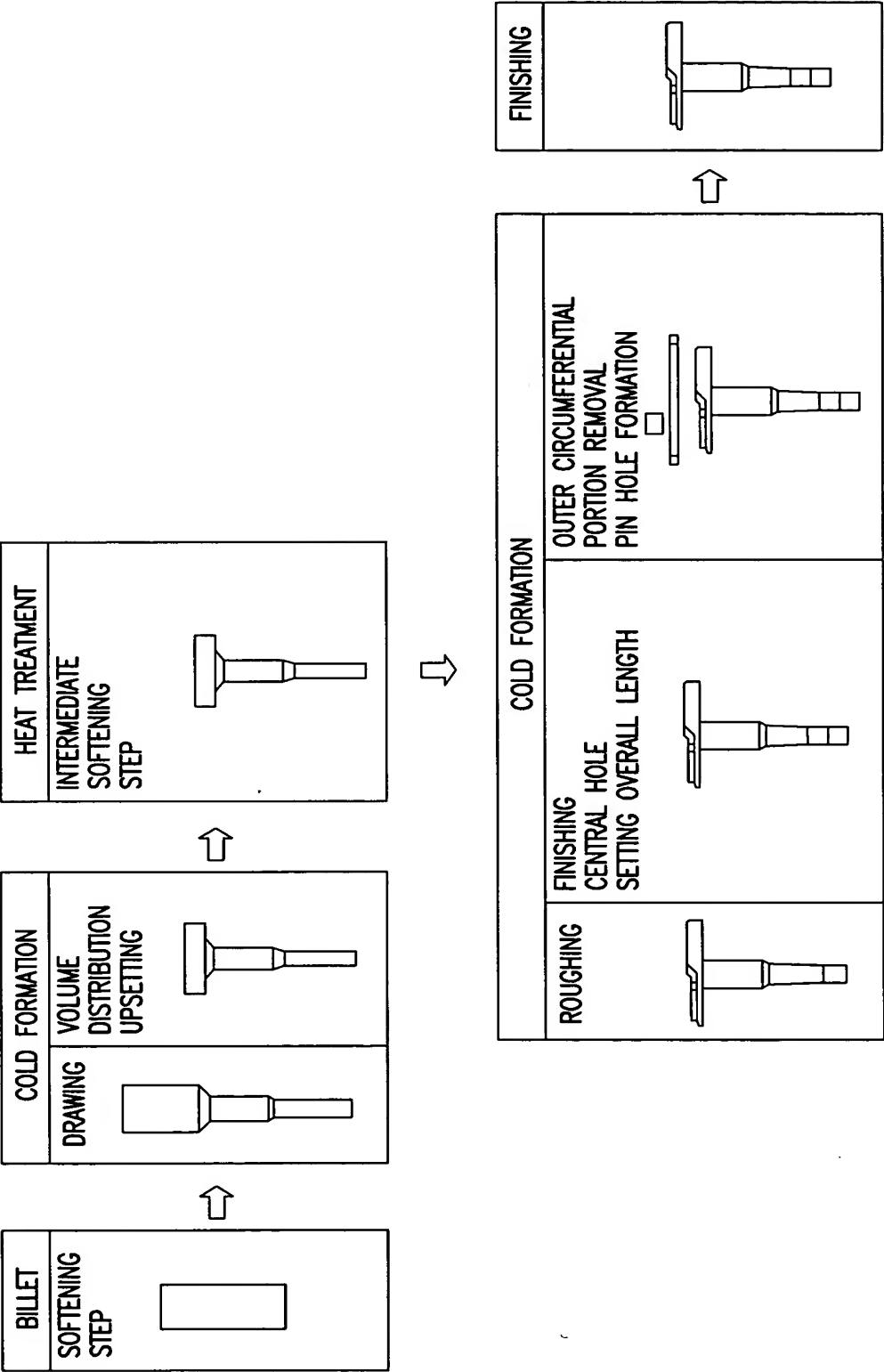


FIG.26

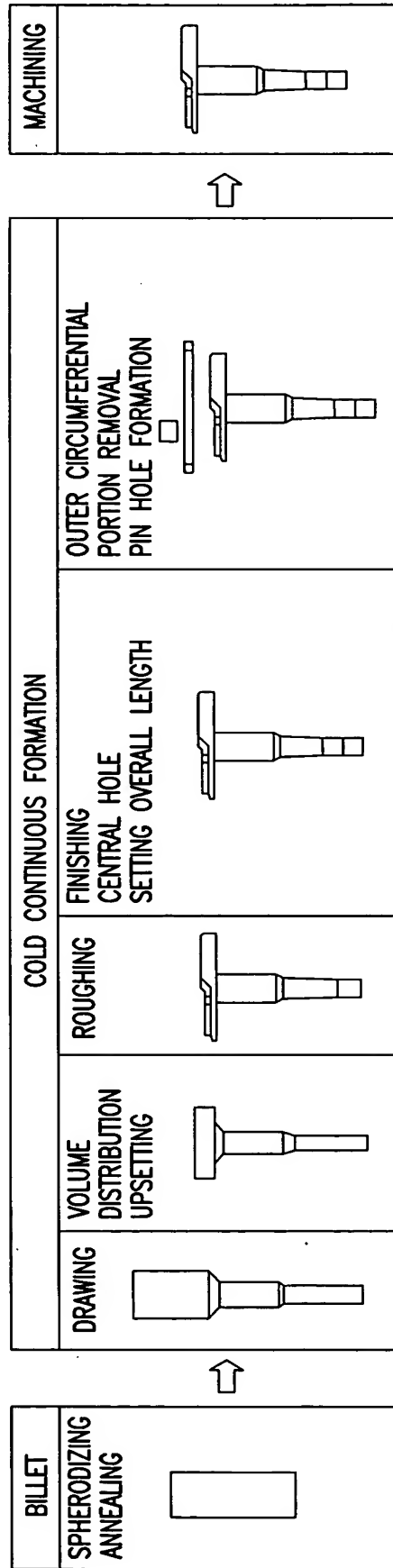


FIG.27

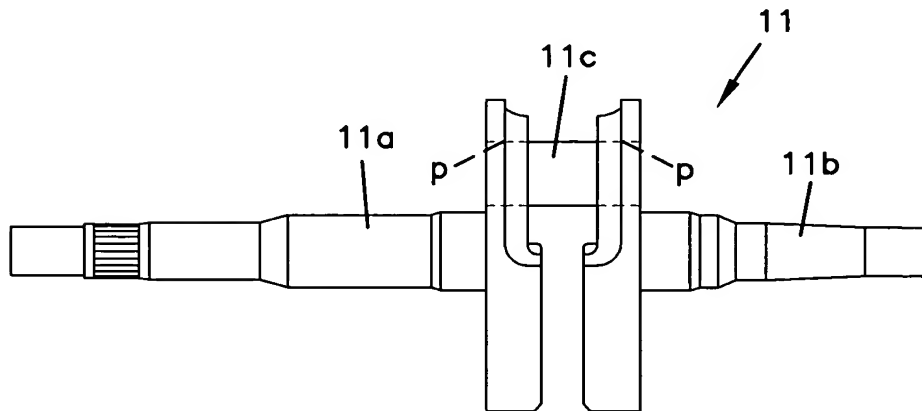


FIG.28

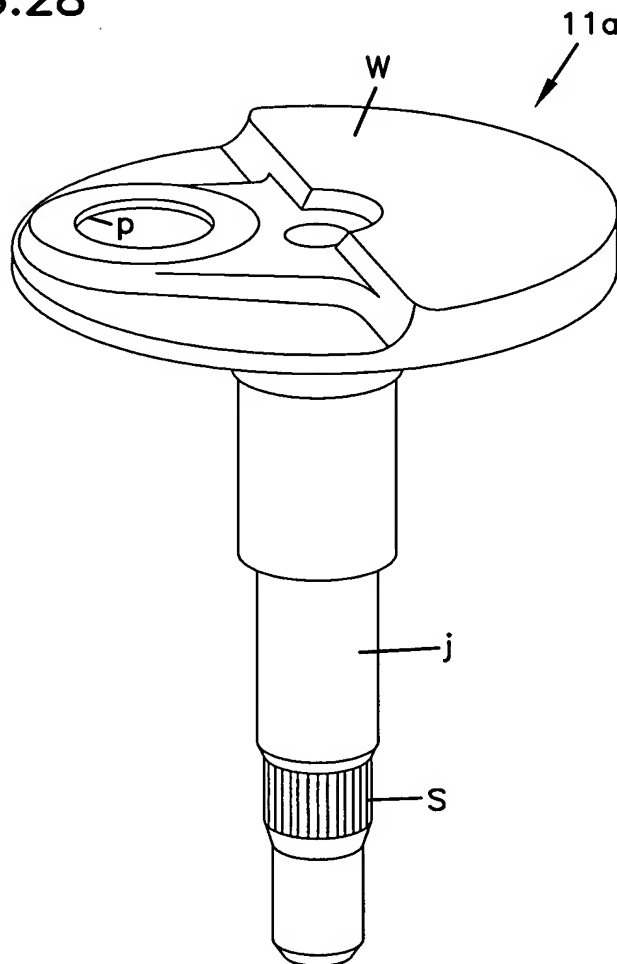


FIG.29A

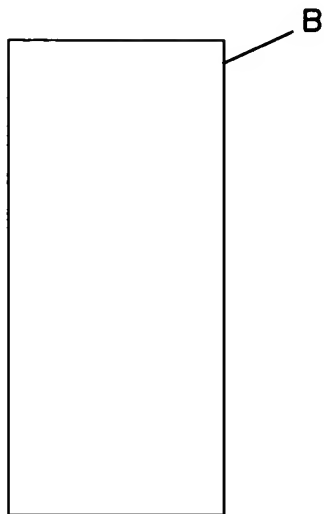


FIG.29B

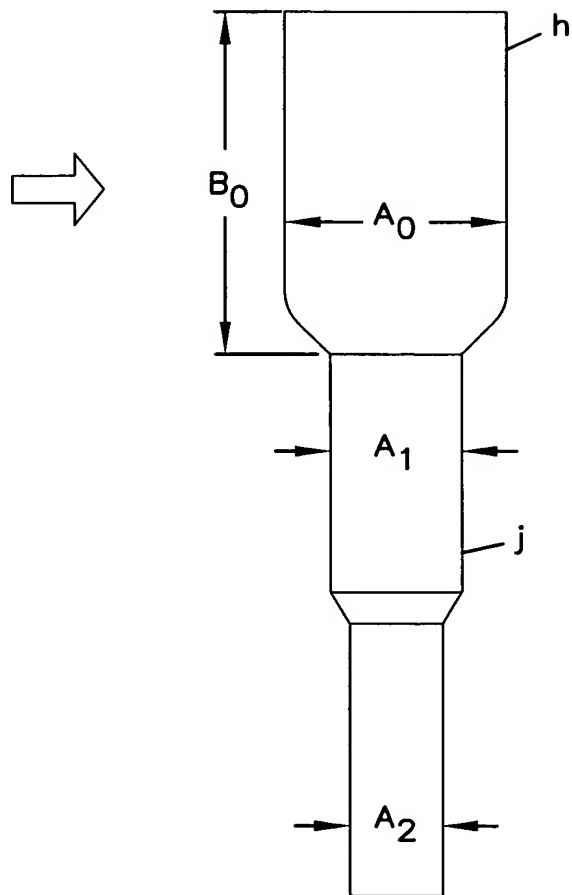


FIG.30A

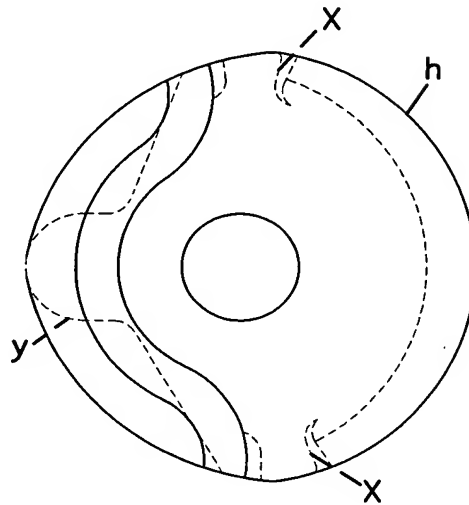


FIG.30B

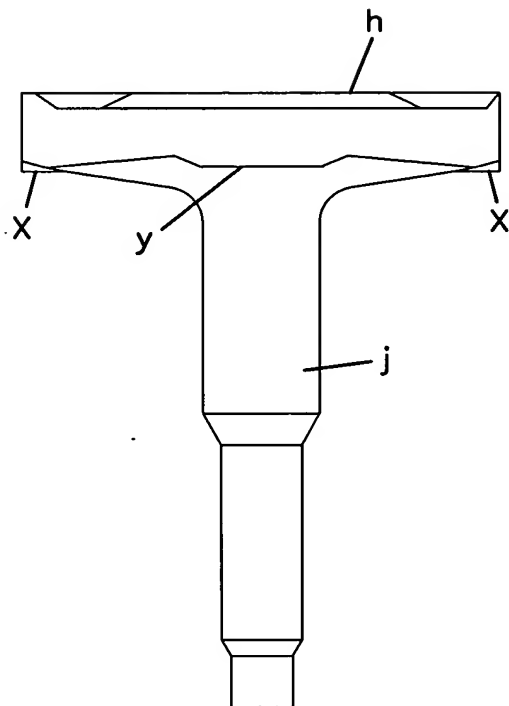


FIG.30C

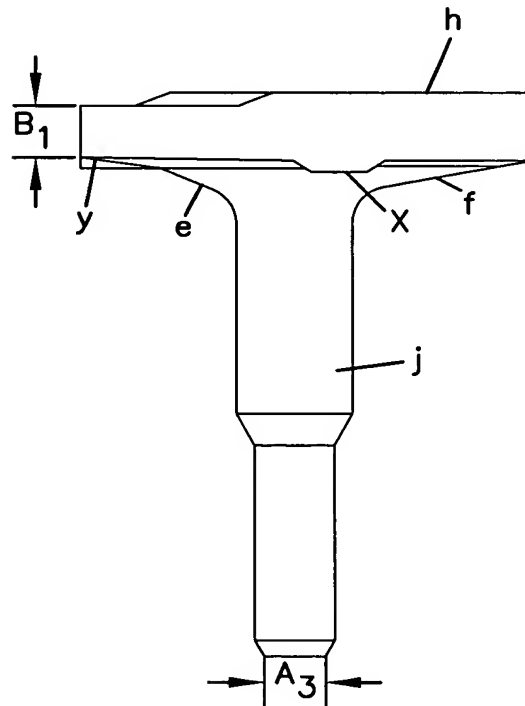


FIG.31A

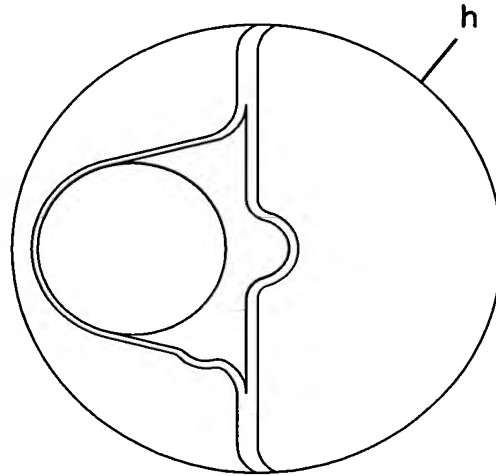


FIG.31B

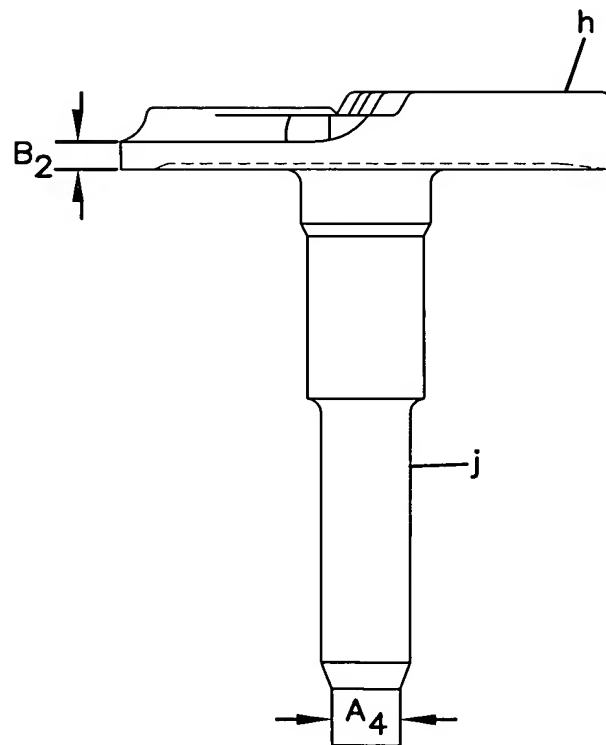


FIG.32A

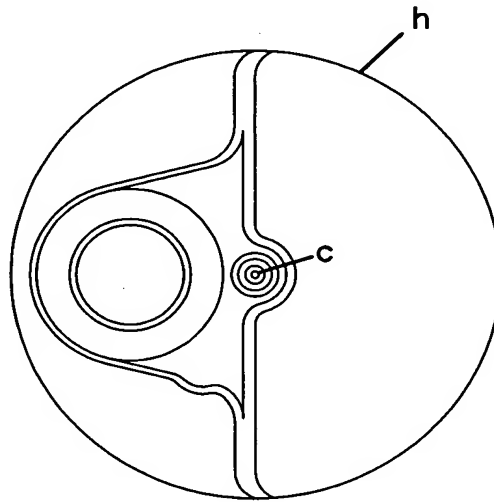


FIG.32B

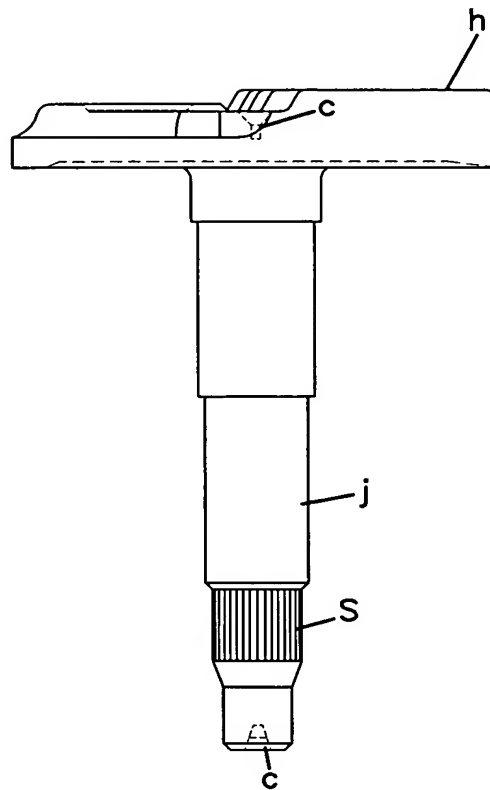


FIG.33A

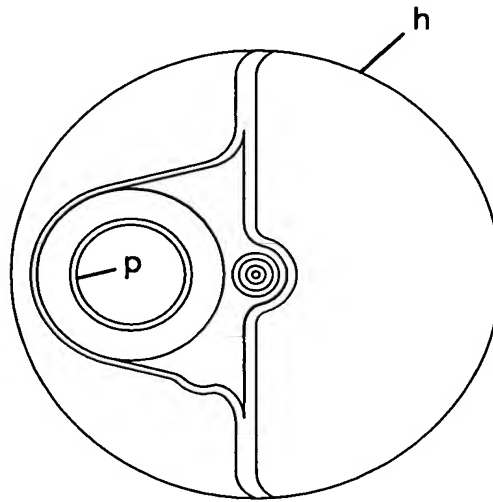


FIG.33B

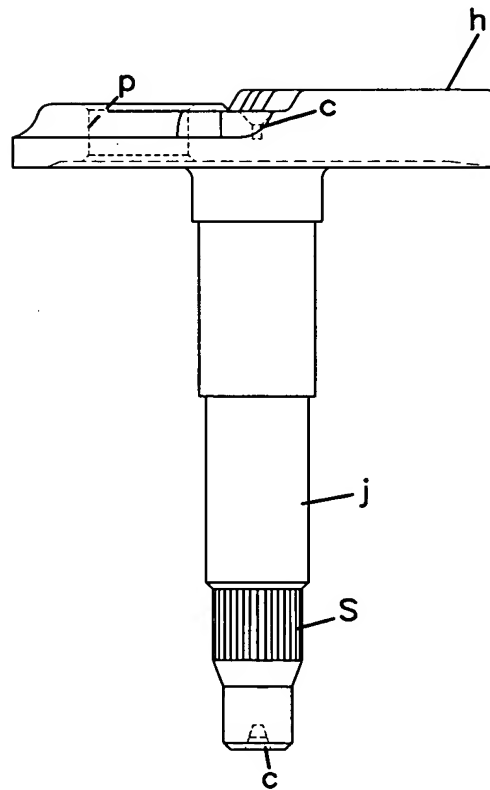


FIG.34A

(INVENTIVE COLD-FORGING METHOD)

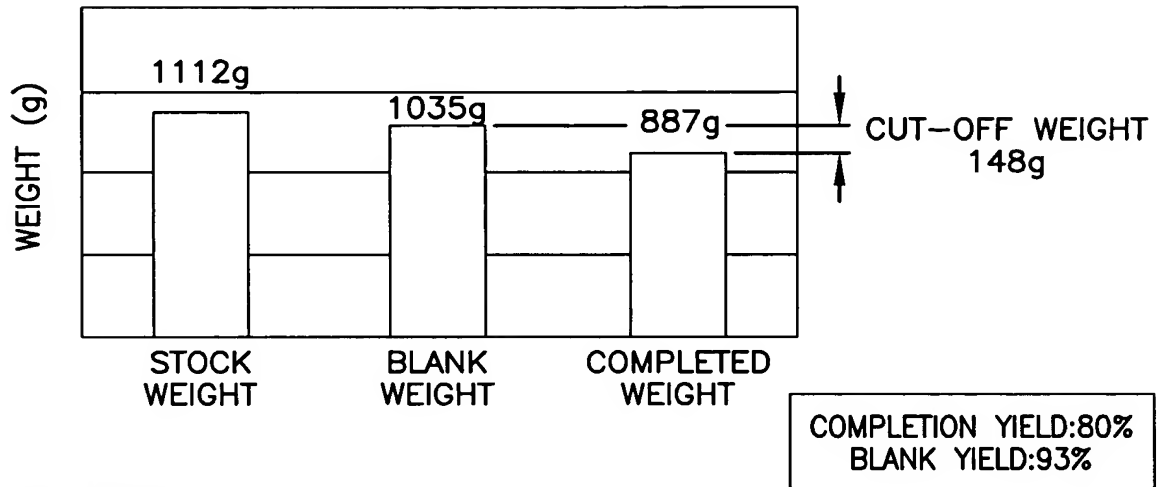


FIG.34B

(INVENTIVE COLD-FORGING METHOD)

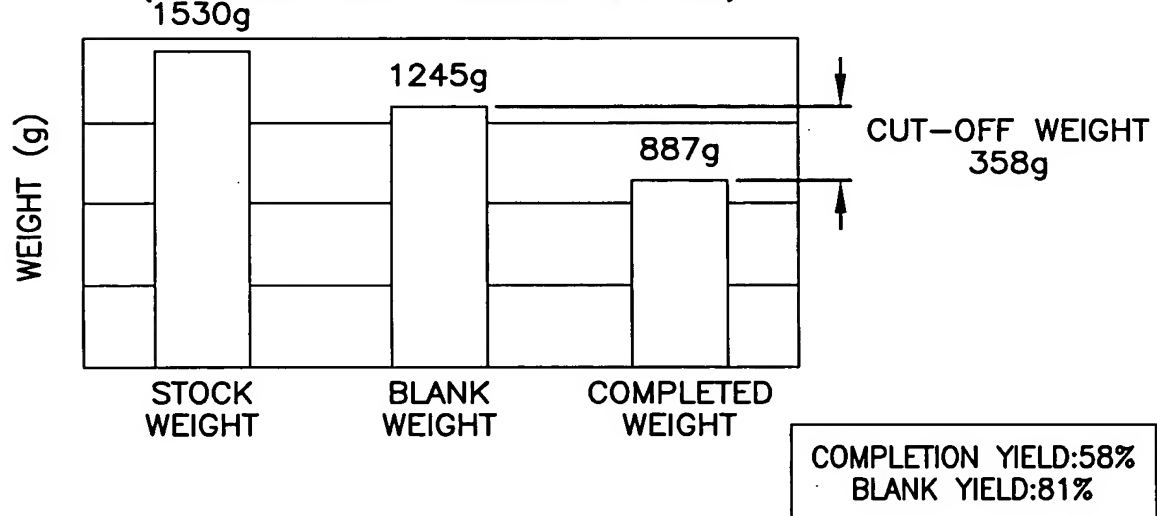


FIG.35

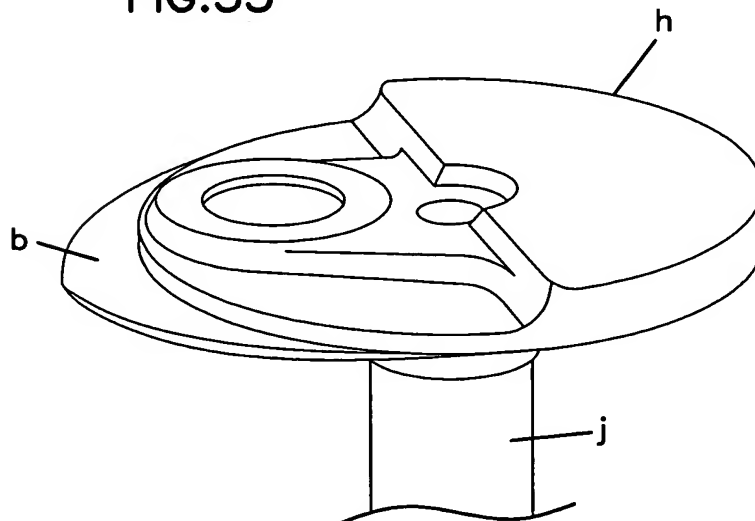


FIG.36A

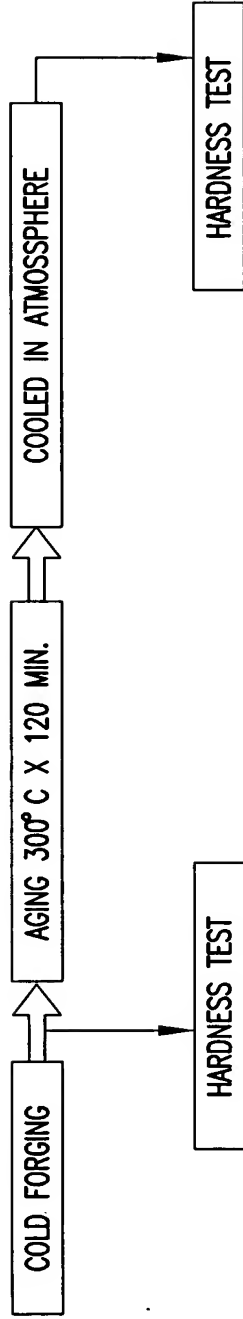


FIG.36B

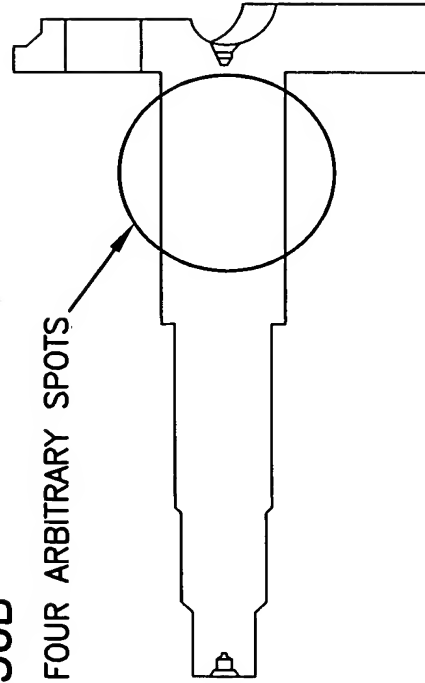


FIG.36C

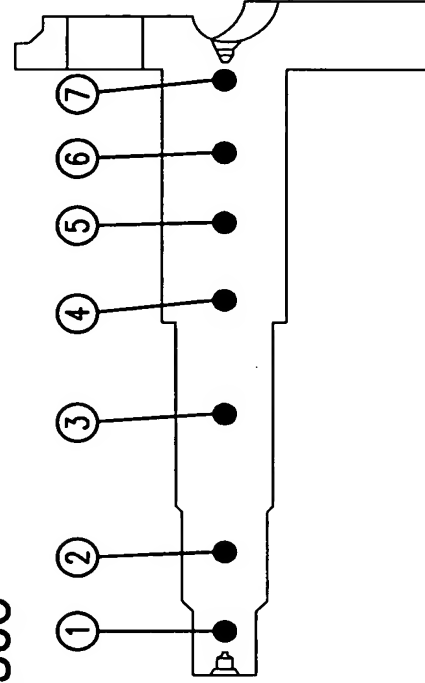


FIG.37A

SLIP TORQUE

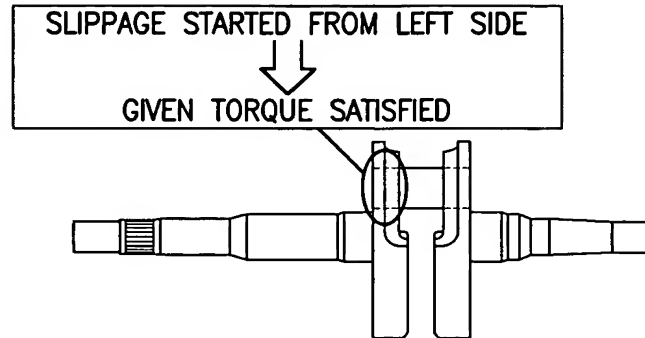


FIG.37B

S - N CURVE (ROTATIONAL BENDING FATIGUE TEST)

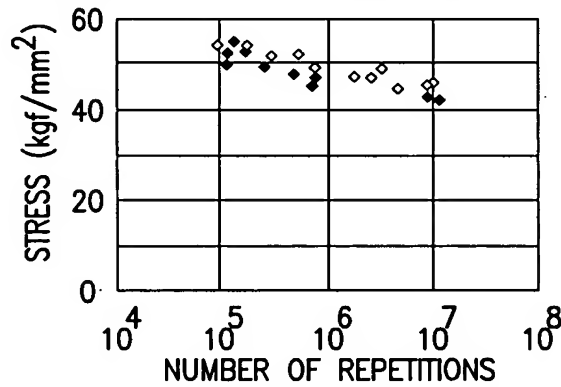


FIG.37C

S - N CURVE (SOLID BENDING FATIGUE TEST)

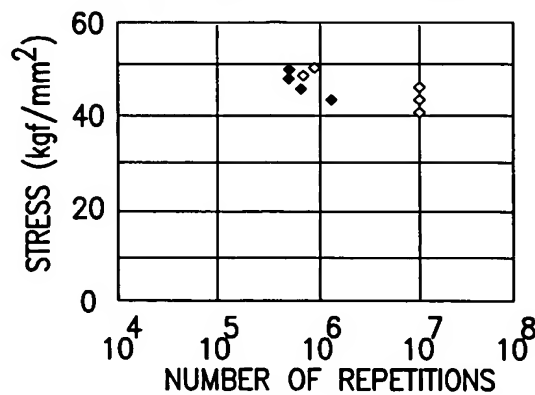


FIG. 39

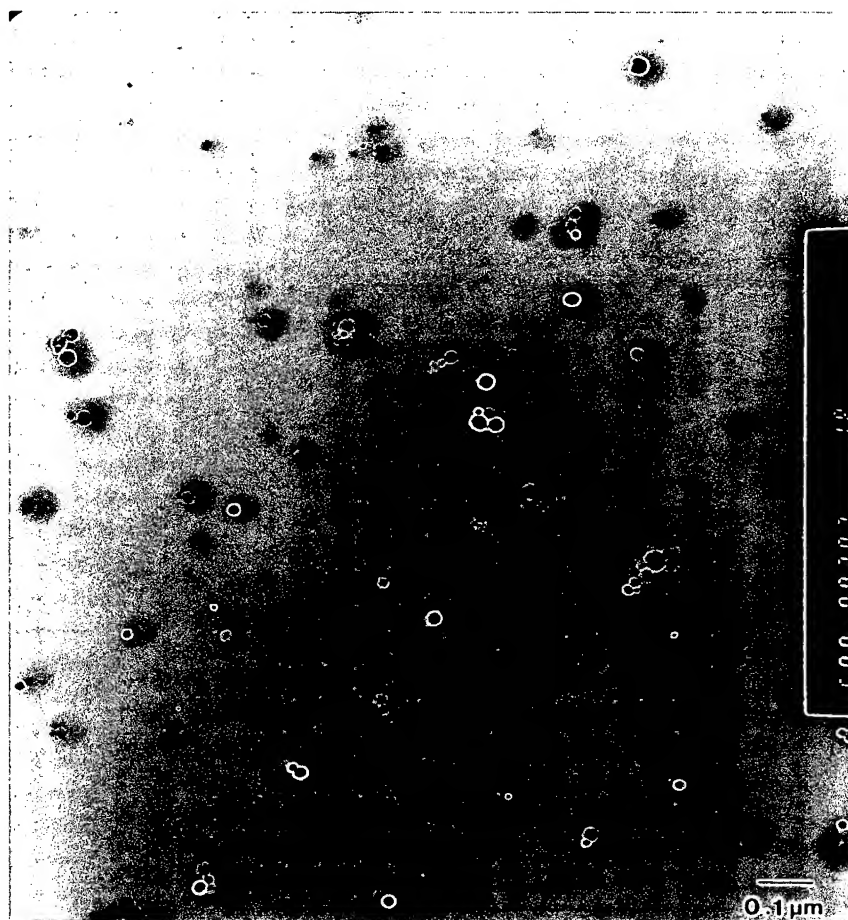


FIG. 38



FIG.40

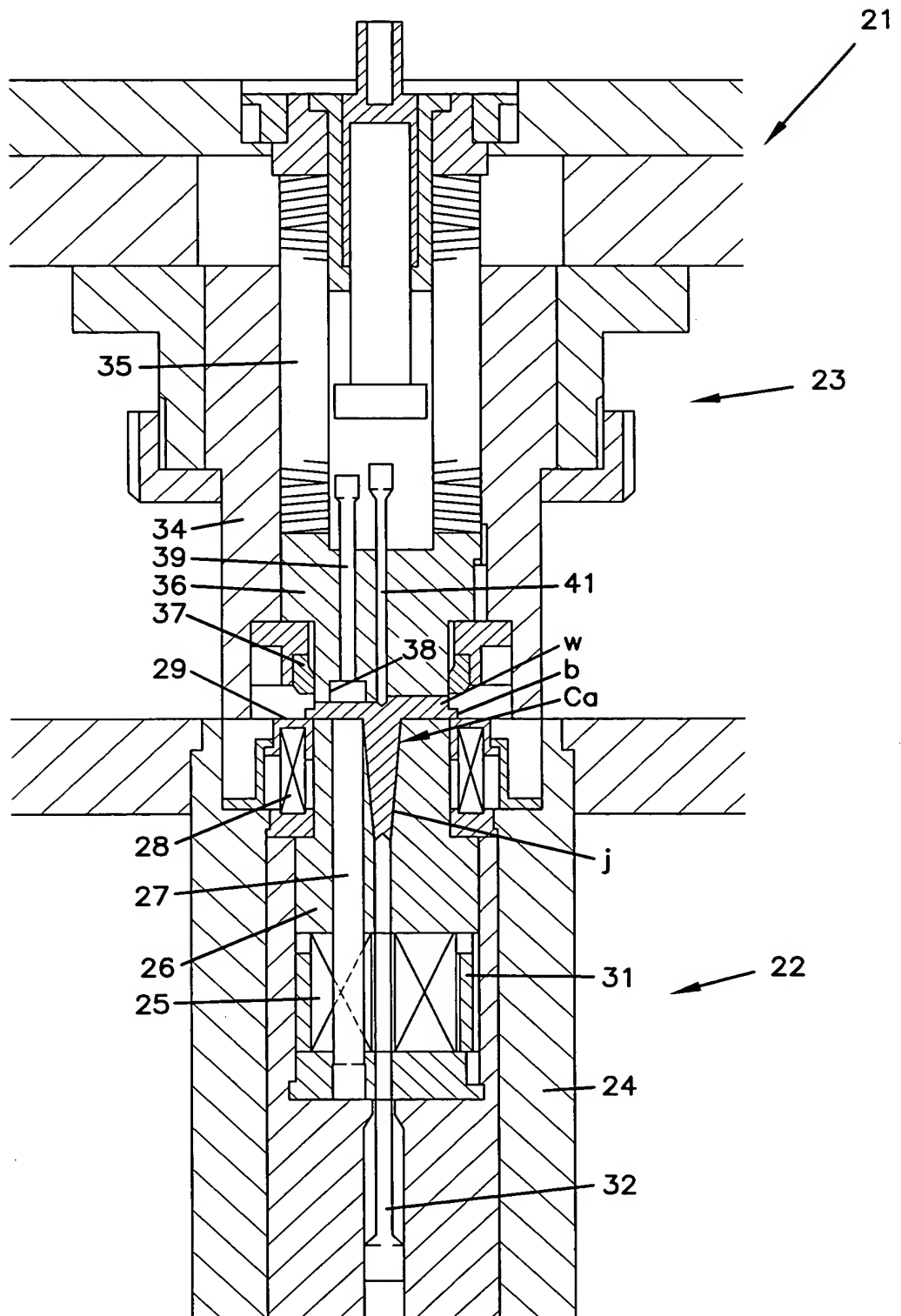


FIG.41A

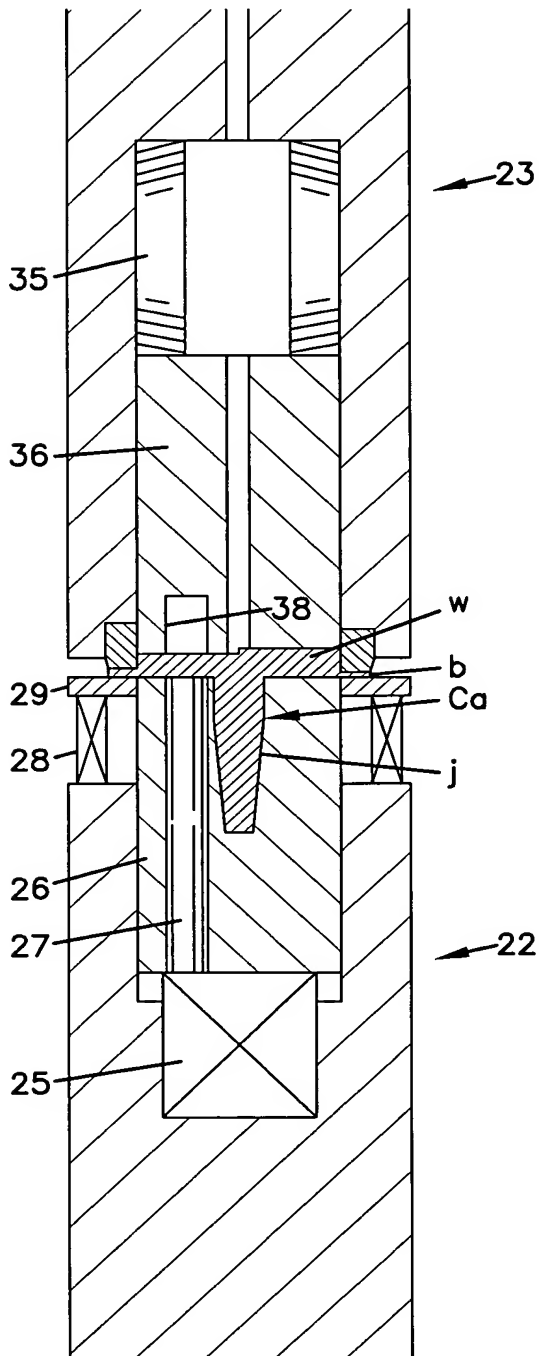
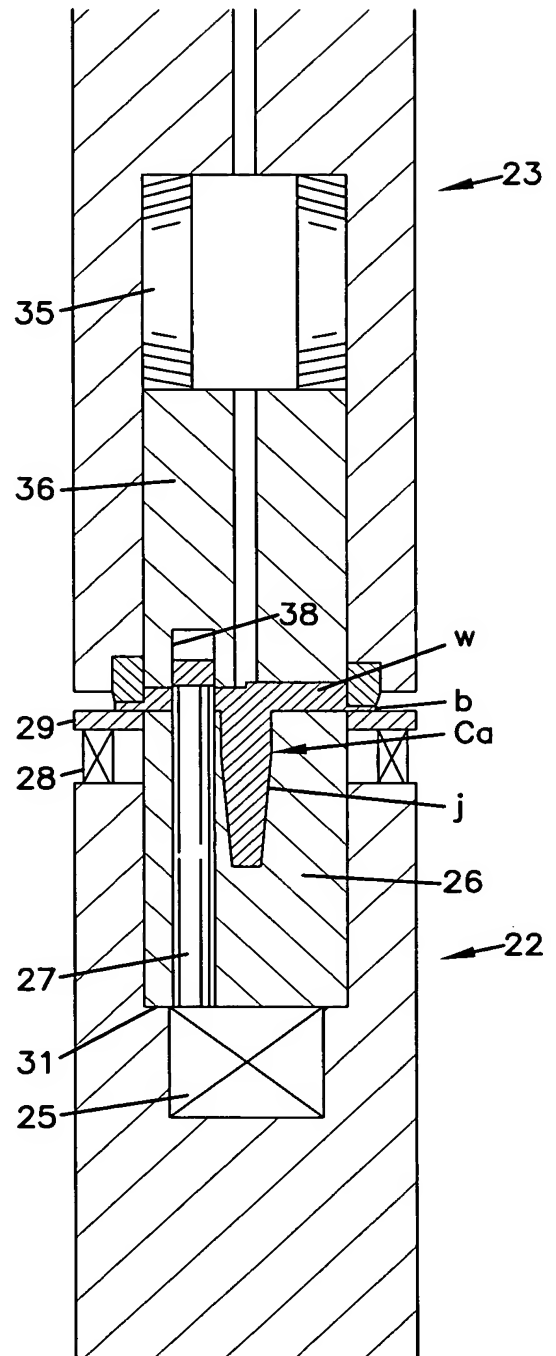


FIG.41B



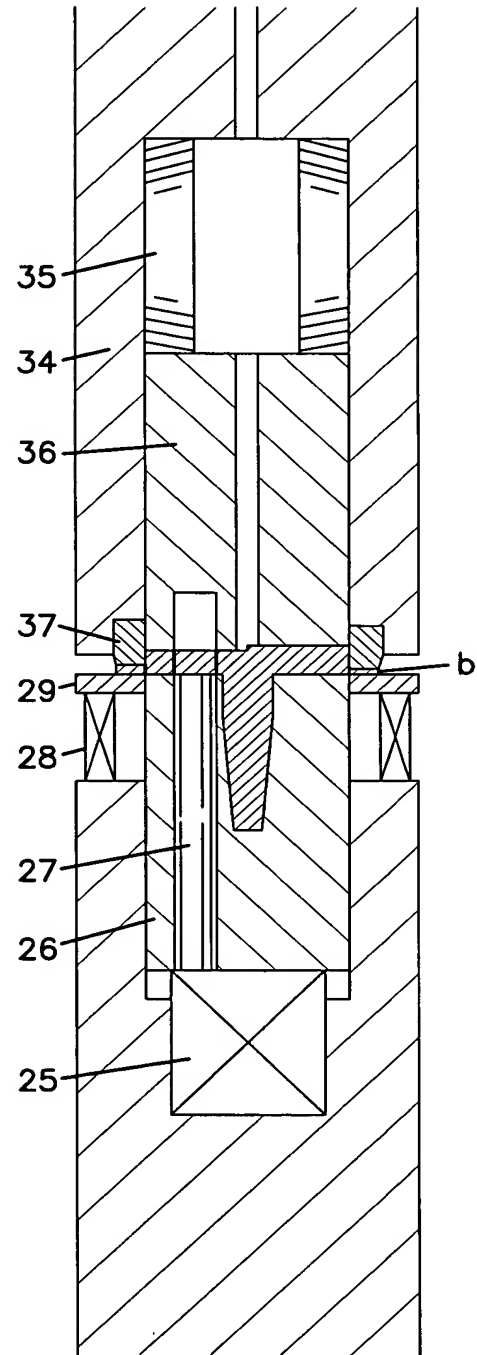
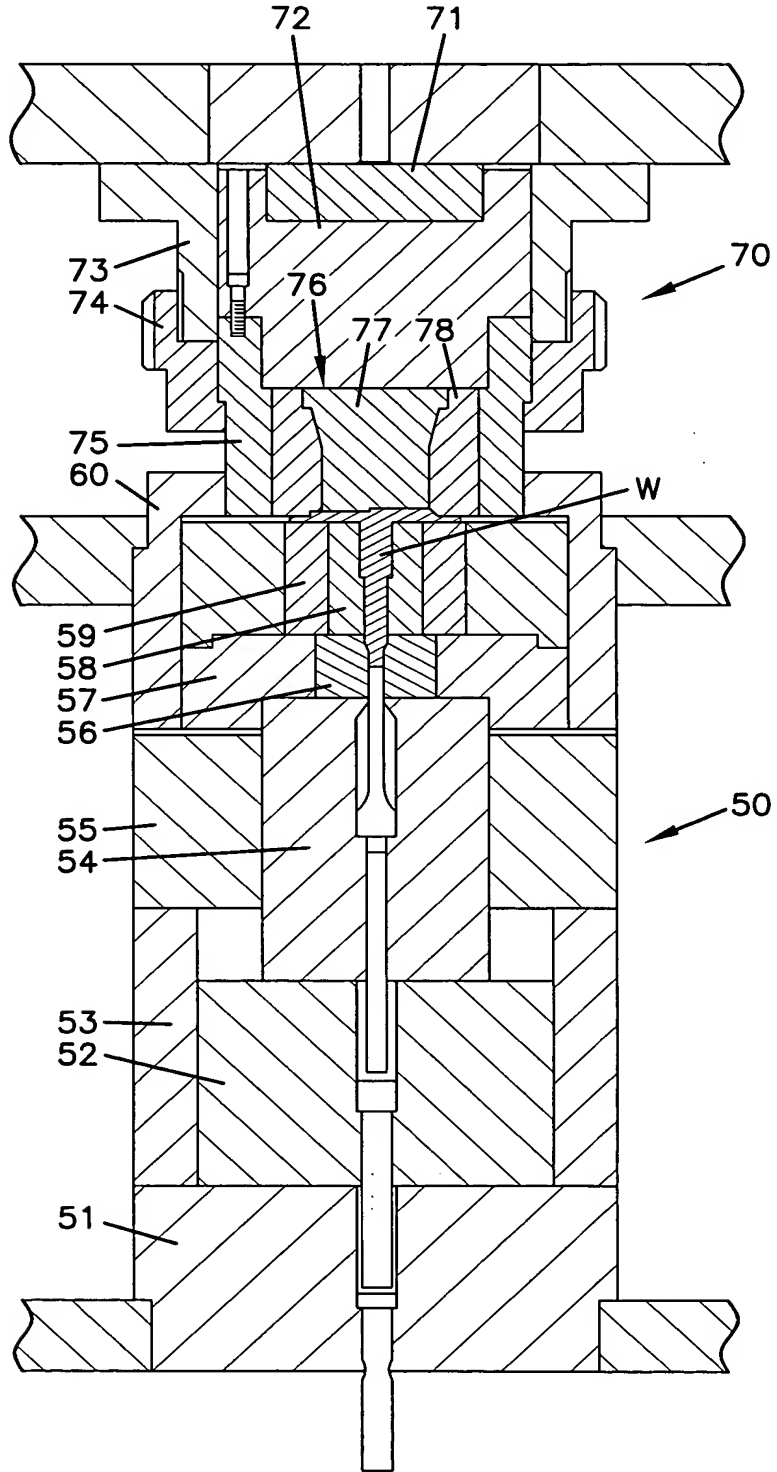
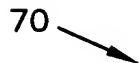


FIG.43



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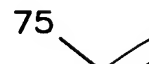


FIG.46

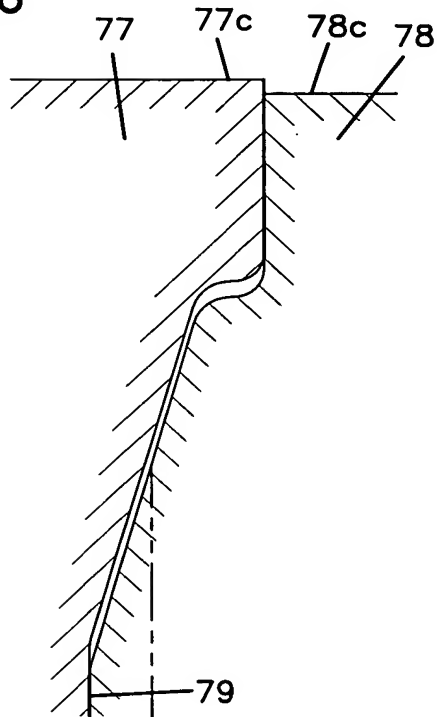


FIG.47

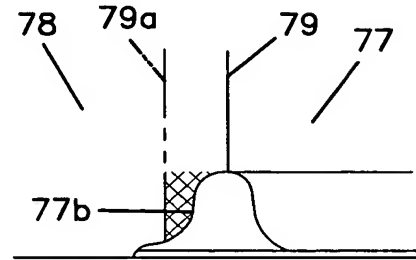


FIG.48

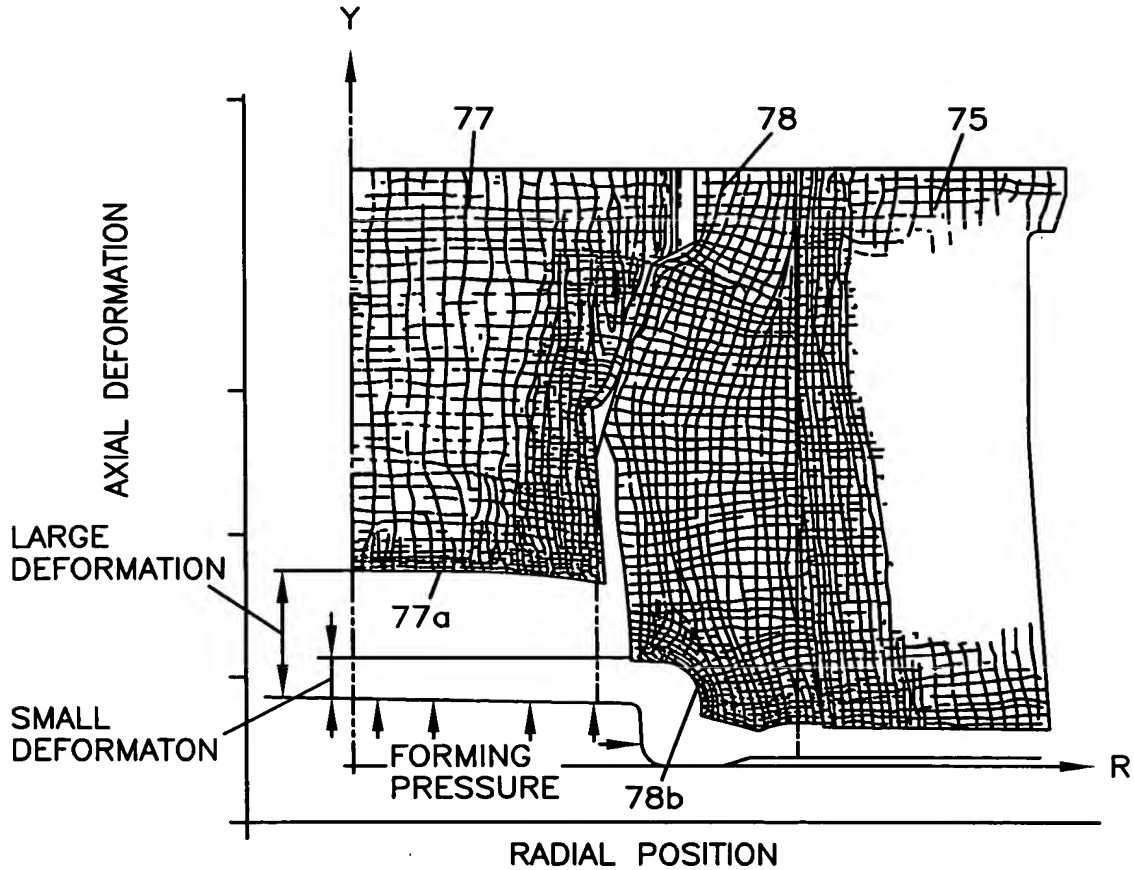


FIG.49

	BILLET MANUFACTURING PROCESS					ASPECT RATIO OF CARBIDE (%)	CRACK PERCENTAGE % N=100
	SPHERODIZING ANNEALING PRIOR TO DRAWING	DRAWING	CUTTING	SPHERODIZING ANNEALING SUBSEQUENT TO DRAWING	SHOT BONDERIZING		
MATERIAL 1	NONE	NONE	○	○	○	506	35%
MATERIAL 2	NONE	(20%) ○	○	○	○	347	5%
MATERIAL 3	○	(20%) ○	○	○	○	300	0%

ASPECT RATIO (%) = $b/a \times 100$

